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InGaN/GaN/ZnO Thermoelectric Properties

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ABSTRACT

The ability to harness waste heat and convert it into electricity via thermoelectric devices is a major breakthrough in green energy. Thermoelectric devices use the Seebeck effect to directly convert a temperature difference into a voltage output, or they can perform active cooling by running a current through the device. They have a wide range of applications, from portable refrigeration to power generation from an exhaust pipe or even body heat. However, the cost, scarcity, and inefficiency of current materials (i.e. Bi_2Te_3, SiGe) has limited the potential of thermoelectric power. With the discovery of better materials, it will be possible to use thermoelectric devices for more applications, increasing the use of renewable energy. The purpose of this study is to determine the thermoelectric properties indium gallium nitride grown on zinc oxide with a gallium nitride buffer layer (InGaN/GaN/ZnO), materials that are more cost effective and environmentally friendly, to determine their feasibility in thermoelectric devices. Several material properties were tested and reported, including the X-ray diffraction scan of the material structure, electrical properties such as conductivity and Seebeck coefficient, and the power factor, which determines the ability of the material to produce voltage. Based on this study, InGaN/GaN/ZnO has shown considerable potential as a material for thermoelectric generators due to its favorable power factor of up to $680 \cdot 10^{-4}$ W/mK^2 at room temperature. In the future, this material should be further tested within thermoelectric devices, and p-type doping methods should be explored to enable the device level performance.

KEYWORDS

Thermoelectric power, energy, nanotechnology, material science